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Comment

Interactive comment on “Assimilating remotely sensed cloud optical thickness into a mesoscale model” by D. Lauwaet et al.

Anonymous Referee #1

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Review of

Assimilating remotely sensed cloud optical thickness into a mesoscale model

D. Lauwaet, K. De Ridder, and P. Pandey

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1 General summary

The paper describes a month-long cloud assimilation study performed with the Advanced Regional Prediction System with the goal to improve near-surface temperatures around Paris. The assimilation procedure is based on 1D-Var retrievals of cloud liquid and ice water content from an integrated observation of cloud optical thickness (COT) from the SEVIRI instrument plus a latent heat adjustment to correct the temperature consistently with the cloud information. Independent temperature, solar irradiance and humidity data are used to verify the impact of the assimilation. Results show that this assimilation procedure has the potential to improve the temperature and solar irradiance fit to observations, while the humidity field is slightly degraded. The cloud field in the assimilation run is substantially different from the run without cloud information.

This study and its results are interesting and of value to further the discussion on the benefits of cloud assimilation to improve numerical simulations of meteorological fields. The technique proposed allows for the impact of the cloud assimilation to be longer lived through the changes in temperature and, more indirectly, moisture. Previous studies have incorporated cloud information in numerical weather prediction models, but 'routine' cloud assimilation is still very much an active research topic. I would therefore recommend the publication of this paper subject to addressing some points listed below.

2 Specific comments and technical corrections

- **Page 13356 line 9:** Actually, what is implicitly assumed is that the background error variance in the horizontal is infinite, or that the horizontal structure is unknown. This is equivalent to an independent pixel approximation where at each pixel the cloud information is retrieved independently from the other points in the

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satellite field of view. This assumption is made by most satellite retrievals. Please reword this sentence to make the point clear.

- **Page 13357 lines 14-15:** This is actually incorrect. The systems that the authors mention are used in operational applications and are therefore rather computationally efficient. Maintenance of the adjoint codes is largely independent of resolution, apart from occasional retuning of the linearized cloud schemes used in the analysis systems. It would be more appropriate to say that only centres with access to large computing facilities can afford to run and maintain these type of systems while research groups in smaller centres and universities need to resort to other techniques for computational feasibility.
- **Page 13358 line 8:** could the authors elaborate more on this - why can ADAS only handle cloud profiling data?
- **Page 13358 line 27:** Replace 'To' with 'The'
- **Page 13360 line 16:** Please add 'The subscript b denotes the background fields'. In general, given that there are many symbols introduced in the paper, please make sure that they are all defined.
- **Page 13361 line 13:** The assumption of a diagonal B matrix is very common. How much more work would be involved if you tried with a simple non-diagonal B-matrix, for example an exponential decay for correlations with a prescribed length scale to be determined with sensitivity studies?
- **Page 13362 line 11:** When a layer contains no simulated condensed water q_{cbi} then there is no information on how much that layer contributed to the cloud optical thickness. This is a common 'problem' when retrieving profiling information from integrated measurements, in the sense that the vertical distribution of the retrieved quantity is entirely dictated by the background. By assigning a cloud

- variance to non-cloudy background layers as a function of saturation and total water content, the authors are implicitly allowing for the analysis to adjust the water vapor profile in absence of background clouds.
- **Page 13363 lines 15-19:** These are strong assumptions - have the authors thought of investigating the sensitivity of the analysis to the choice of these parameters? As a general comment, it is common practice in the retrieval community to provide retrieval products, for example cloud optical depths, and not to provide pixel-level uncertainties. While for other applications this might be perfectly fine, from an assimilation perspective this is rather poor, because the data users are left with the task of *arbitrarily* assigning errors at the pixel level, and that can lead to severe errors in the analysis.
 - **Page 13365 line 7:** For those readers not familiar with cloud retrievals it might appear unclear why the assimilation is only active during the day. Please explain.
 - **Page 13365 lines 25-30:** Would having correlations in B help with this?
 - **Page 13366 line 18:** It would be good to have some verification results for stations in that area where the assimilation had the biggest impact. Are there any stations available that the authors can use?
 - **Page 13366 line 25:** Comparison with assimilated data can only be used to check the first guess, and to see how the assimilation fared. The authors need to use independent data to assess the performance of their system. Please add one or two figures in which the cloud data are quantitatively assessed with, for example, MODIS and/or MISR optical depths. That can also give a measure of the quality of the COTs derived from the SEVIRI instrument (also a way to independently check that the error assumptions reported on page 13363, line 18 are reasonable).

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- **Tables:** Please report temperatures in Celsius. It is more intuitive when speaking of surface temperatures.
- **Figures 3 and 4:** The x-axis unit is odd - please use days. For clarity, it would be useful to have another plot with the zoom over June 15–17, for example, where the impact of the assimilation was the largest.
- **Figure 6:** Some verification in the areas of biggest impact (South-West France and Alps) would be welcome.
- **Figure 7:** Cloud fields need to be assessed more quantitatively using *independent* observations.

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